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Potential Utilization of Agricultural Resources

The Case of Jojoba

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POTENTIAL UTILIZATION OF AGRICULTURAL RESOURCES: THE CASE OF JOJOBA.
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ABSTRACT

This research is a part of a more comprehensive economic assessment of industrial crops as an alternative to reduce U.S. agricultural excess production capacity. The overall study goal is to determine the extent to which agricultural resources can be shifted from traditional food and fiber crops into the area of industrial feed stocks such as special oils. The study employs an economic model, developed for jojoba, which examines the economic performance of continuous jojoba production over 25 years under changing yields and prices.

Keywords: Jojoba economics, production costs, prices, yields.

ACKNOWLEDGMENTS

Since little data exist regarding growing, processing, and marketing of jojoba, this work relies on the experience and knowledge of many people who are currently involved with the jojoba industry. Although these people have shared their knowledge and experience, the author is responsible for the assumptions, interpretation, conclusions, and any other material contained in this study. Appreciation is expressed to all who helped, especially the following people: LeMoyne Hogan, David Palzkill, Stan Alcorn, K.C. Hamilton, with the Department of Plant Science, University of Arizona; Scott Hawthorn, Department of Agricultural Economics, University of Arizona; Gene Wright, Office of Arid Land Studies, University of Arizona; Carol Whittaker, Tim Timmons, Hyder Jojoba Inc.; John Tyron, Desert Farm Management Inc.; Hal Purcell, Jojoba Growers Association and McVay Jojoba Inc.; Michael Purcell, Larry Cross, McVay Jojoba Inc.; John Hogan, California Farm Management Co.; Dale Bucks, Francis Nakagam, USDA, Water Conservation Lab., Phoenix, AZ; Kelley Shooter, Frank Flider, Jojoba Marketing Cooperative; Vicki Hubbard, Associated Jojoba Industries; Arnold Gavin, EMI/EXIM; George Arndt, Wynn Oil Company; Ron Kadish, Ag Associate; and M. Aberham, Netafim Irrigation Company.

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INTRODUCTION

This research is a first part of a more comprehensive study on the feasibility of industrial crops as a means of reducing U.S. agricultural excess production capacity. The overall study goal, which includes other crops as well as jojoba, is to determine the extent to which agricultural resources can be shifted from traditional food and fiber crops into the area of industrial feed-stocks such as special oils and derivatives, pulp and paper products, natural rubber, and other products. In addition, the overall study is aimed at evaluating the economic impacts of new industrial crops on farm income, food prices, and the balance of payments. A major goal of the overall study is to evaluate the possible tradeoff between current farm support programs that emphasize cropland diversion as a main method of reducing commodity surpluses and programs that promote the shift of idle cropland and other resources into the production of new crops.

The analysis presented here is a preliminary economic evaluation of jojoba. Its specific objective is to estimate the cost of production as well as to assess the economic viability of commercial jojoba production in the southwestern United States. Such information and data are essential for a preliminary decision on whether or not jojoba should be included in the overall study mentioned above. Other information on jojoba can be obtained from the Jojoba Growers Association 1/, the Office of Arid Land Studies, University of Arizona, Tucson and from (4, 6, 11) 2/.

Resource allocation has long been a major issue for the agricultural sector. Beginning in the early fifties the government was forced to adopt policies that diverted some resources out of active production when production exceeded consumption. Although most of the diversion programs concentrated on land diversion, they also resulted in idling other agricultural resources such as water, machinery, and labor.

1/ 142 Front St., Avila Beach, CA 93424.
2/ Underscored numbers in parentheses refer to sources listed in the References in this report.

Due to the nature of the resources used in agriculture, only labor moved relatively quickly to other sectors of the economy. Farmland, water, and farm machinery generally stayed in the agricultural sector due to lack of production opportunities in the other sectors. Near urban areas, however, some farmland was converted to urban or industrial uses. In other cases, most notably in California and Arizona, municipalities are engaged in purchasing entire farms to be able to shift the water from agriculture into municipal and industrial uses. Overall, these exceptions had relatively little national impact on resource use in agriculture.

The issue of excess resources in agriculture was not considered a major problem in the seventies as the demand for farm products increased substantially and brought production very close to "full capacity" (2). However, the decline in exports in the eighties once again focused the public attention on resource allocation in agriculture.

As the demand for farm products declined in the eighties, more and more resources have been taken out of production. However, the movement of resources out of active production was not as fast as the reduction in demand for agricultural products. Thus, commodity surpluses continued to accumulate in already overflowing stockpiles.

Excess capacity in U.S. agriculture is clearly evident in the western part of the country. Reduced demand for agricultural products is the main reason for the reduction in land and water use. Between 1979 and 1984, irrigated acres in Arizona declined by more than 350,000 acres and the amount of water applied there declined by more than 400,000 acre-feet. A similar situation exists in California (7, 9). A major part of the decline in land and water use is due to a reduction in cotton production. Cotton planting in Arizona and California declined from a peak of 2,230,000 acres in 1979 to 1,772,500 acres in 1985 (7, 10).

Agriculturalists have been looking for new crops as a way to offset the slow shift and the inelasticity of the aggregate demand curve for agricultural products. This effort gained attention as demand for agricultural products declined in the eighties. Special attention and effort have been devoted to crops that might be a source of industrial raw materials since these crops will not be competing with existing food crops. Jojoba was suggested initially as a replacement for sperm whale oil and is especially adapted to the southwestern states (Arizona and California). In the last few years, jojoba oil has also been used as raw material in the pharmaceutical and lubricant industries.

JOJOBA IN THE UNITED STATES

Jojoba is a shrub native to the Sonora Desert in Arizona and California. It is a slow-growing perennial crop that has been grown commercially only in the last 10 years. Jojoba produces an oil that is similar to, or even superior to, sperm whale oil. A major boost to the production of jojoba oil was the ban on sperm whale oil and products in 1971.

The jojoba oil is a pure liquid wax aster that is a natural base for cream ointments as well as many other products in the cosmetics industry. In the last few years, jojoba oil was also found to have desirable properties as an additive for lubricant products. Lubricant products containing jojoba oil have performed as well as or even better than similar products containing petrochemical additives.

The strong demand for jojoba oil in the seventies and early eighties led to rapid development of jojoba growing in the lower desert of California and Arizona. Expected high returns and the availability of tax investment credits lured many nonagricultural venture capitalists to invest in jojoba plantations. These venture capitalists formed corporations and limited partnerships that purchased land and planted jojoba. Much of the land purchased was previously irrigated cotton land. Today there are approximately 40,000 acres of jojoba in the area extending from Bakersfield, CA, Phoenix, AZ.

During the development of much of the jojoba acreage, wild picked jojoba seeds were used for commercial planting because of the unavailability of high-yielding varieties and the inexperience of the producers who rushed to get into the business. Many of the wild seeds produced low-yielding plants with different growth rates, different shapes and, generally, nonuniform and low-yielding fields.

Jojoba plants are either male or female, with the male plants producing pollen and the female plants producing the seeds. Obtaining high yields requires a small proportion of male (10-15 percent) and high proportion of carefully selected female plants (85-90 percent). However, the sex of the plants cannot be determined until the first flower buds appear, and this might take 1-3 years. Thus, seeded fields require continual removal of male plants and replanting of female plants in the first few years. In some fields, upgrading might also require that low-yielding female plants be replaced with better plants from cutting material. This increases even further the uneven uniformity of the fields, delays commercial harvesting and significantly reduces the yield potential of the fields. Uniform growth is essential for efficient mechanical harvesting as well as adequate irrigation and weed control. Other problems currently facing jojoba producers are:

1. Even though jojoba plants can withstand very low temperatures, they might lose their yield entirely for one season if they are exposed to severe cold (25 degrees F or lower) during blooming season (January - March). Although jojoba is usually planted in desert areas with very high summer temperature, some of these areas might be susceptible to very low temperature on clear winter nights. For example, frost damage in 1985 and 1986 devastated much of the jojoba production in Arizona for those years.

2. Since jojoba is a perennial crop, weed control is a critical problem, especially near the plants. Many of the fields planted, especially fields where cotton had been grown previously, have expensive and serious weed control problems.

3. Due to the lack of experience and research in commercial jojoba planting, spacing between rows is not always adequate. In some cases, the spacing was too narrow, making it inaccessible to farm equipment. In other cases, the spacing was too wide, reducing per acre yield potential.

Awareness of the problems above have made current planting of jojoba very different than in the past. Most important, all new fields are using cuttings or tissue-cultured material of selected plants rather than seeds. This is done by producing plants in nurseries from clipped material of carefully selected high-yielding female plants or male plants that produce abundant pollen. Using cuttings results in fields with a fixed and known proportion of male to female plants, as well as plants of uniform maturity with high yield potential.

Other improvements include careful weed control before planting, improved land preparation, improved irrigation, and appropriate spacing both between rows and between plants. Since pollination is mostly done by wind, some growers take into account the prevailing wind direction in winter months when deciding on the location of the male plants in relation to the female plants.

In short, the current generation of jojoba is a significant improvement over the early jojoba plantations. It is not yet known how many of the earlier 40,000 acres are commercially viable. As mentioned above, many fields have low yield potentials. On the other hand, several thousand acres planted with cuttings are expected to have much higher yields and stand a very good chance of being economical. Even though many of the current acres may be unprofitable if, as expected, jojoba oil prices decline, the industry as a whole is very active. Many of the people involved have shown a real pioneering spirit and have managed to bring about growth of the jojoba industry. Most of their efforts, thus far, have had very little direct help from public or government organizations.

METHODOLOGY

The methodology used in the economic analysis of jojoba production is based on a comprehensive jojoba budget developed and analyzed on a LOTUS 1-2-3 spreadsheet. The model (see Appendix) is a set of linked tables containing data, assumptions, and mathematical relationships associated with an enterprise of 1,000 acres of jojoba. Each table contains different information such as investment, operating costs, cost of material, etc. Appendix tables 13-15 contain the economic results from the jojoba budget.

General Assumptions

Almost any kind of economic analysis requires some assumptions to compensate for unknown or missing information. This is especially true for a new crop such as jojoba. Another difficulty is the fact that the current jojoba industry is very dynamic. This is reflected in a rapid development of production from just a few tons in the mid-eighties to thousands of tons by the late eighties. New varieties, better cultivation methods, and the use of cuttings instead of seeds

can be expected to increase production substantially. In addition, promoting jojoba as a possible substitute for currently idle cotton acres in the Southwest will likely bring additional acres into production. However, increased production will likely bring prices down. The rate of price decrease will depend on development of new markets for jojoba oil as well as increased demand for jojoba oil in current markets such as the cosmetics market.

In general, the analysis simulates a future outlook for jojoba production based on current knowledge as well as on expected changes. These changes are especially important for prices and yields. The following is a detailed explanation of the assumptions used in the analysis.

1. Land Development: The jojoba budget assumes that jojoba is planted on previously developed privately owned irrigated cotton land. This assumption is required in order to be consistent with the overall study on new crops and agricultural excess capacity. Thus, it is assumed that the farm already has all the required infrastructure including surface irrigation system, power and telephone lines, roads, and buildings. This means that the analysis does not take into account any investment in farm infrastructure except for investment in drip irrigation system as noted in the Appendix. It also means that the net return calculated by the model includes return to land and other infrastructure.

2. Size of Farm: For simplicity, the farm size is assumed to be 1,000 acres. Therefore, all the tables in the model are expressed on a 1,000-acre basis.

3. Area of Application: The current analysis has been developed and applied to the area covering south central Arizona and the lower California desert. These areas are suitable for jojoba production and had a large decline in cotton acres. However, It is assumed that jojoba will be planted only in frost-free locations in the Southwest.

4. Jojoba Oil Prices: Jojoba oil prices have decreased substantially in the last few years. For example, jojoba oil was selling for about $75 a gallon in the beginning of 1985; by the beginning of 1986, it had dropped below $40 a gallon (3). The decline in prices is expected to continue due mainly to continued increases in production and development efforts to extend jojoba oil to other uses such as the lubricant market, which is likely to pay less than current prices. Such a reduction in jojoba oil prices is likely to be even more significant if jojoba planting accelerates as a way to use additional idle cotton acreage. Since no marketing study of jojoba oil is available, the reduction in jojoba oil prices is based on discussions with industry personnel and jojoba oil users. It is also based on the fact that jojoba oil prices have declined sharply in the last few years.3/ Figure 1 presents the base assumption on jojoba oil

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3/ The sensitivity analysis conducted in this study examines different possibilities of price changes.

Figure 1. Expected jojoba oil prices under different alternatives

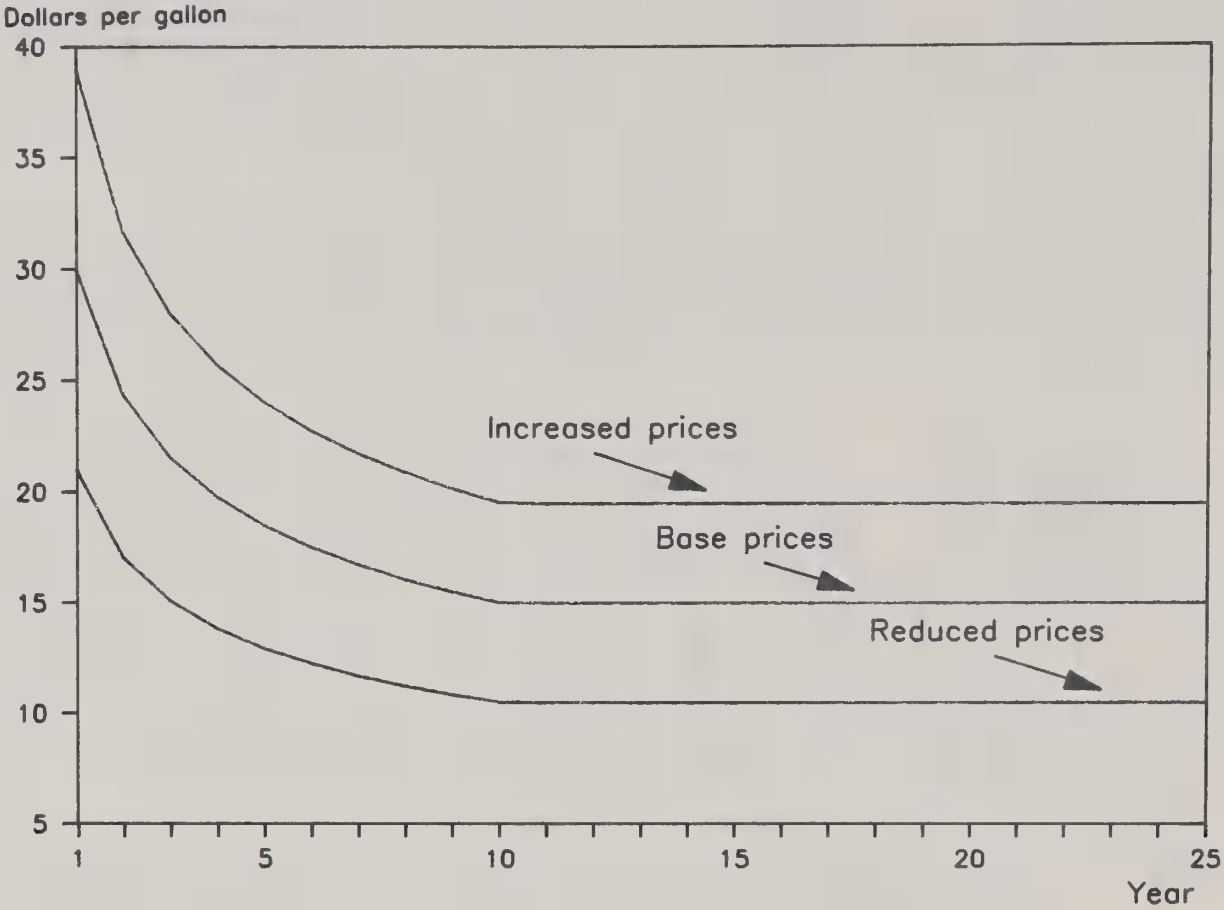
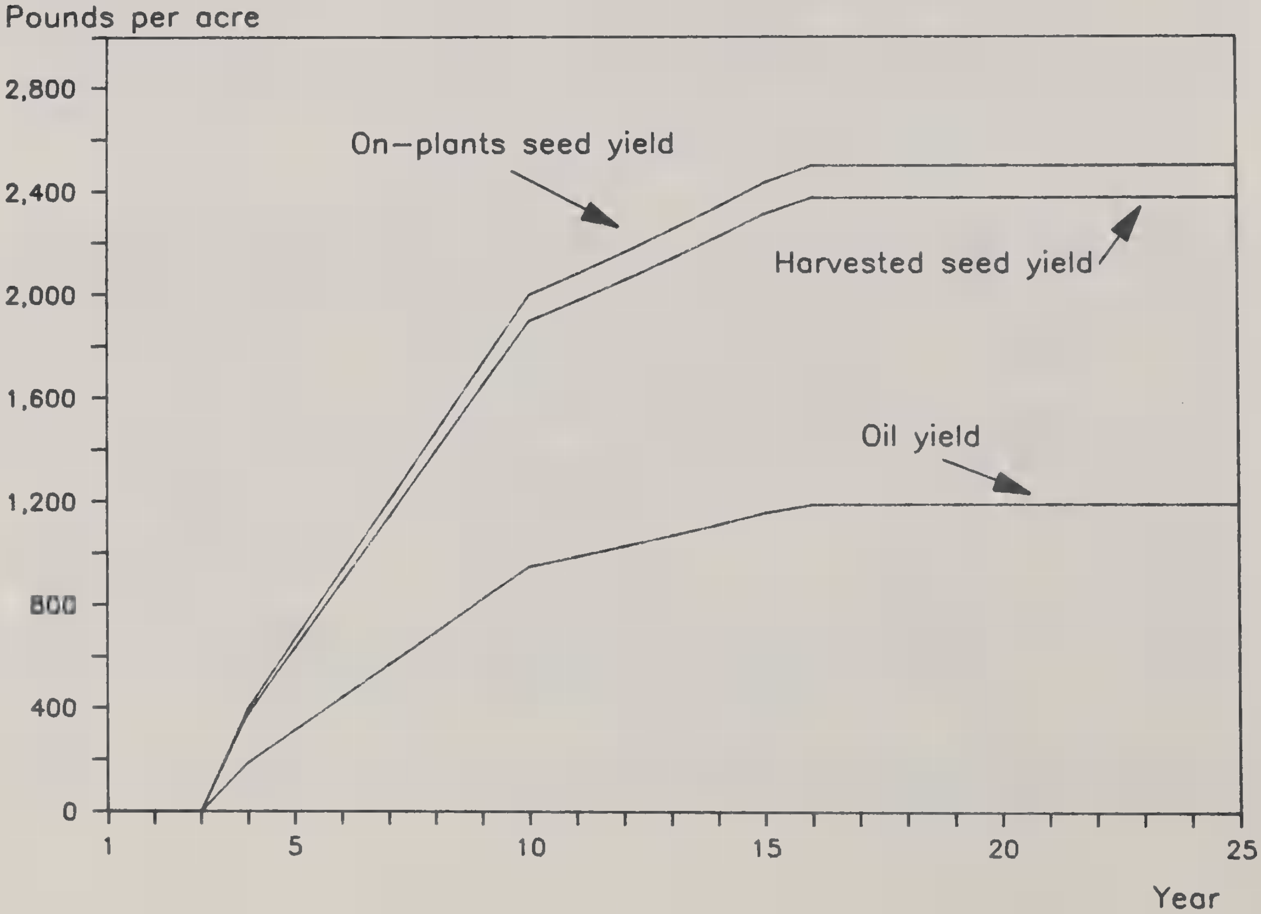


Figure 2. Expected jojoba yields under base alternative



prices. From $30 per gallon in the first year, prices are assumed to stabilize around $15 a gallon ($2.08 per pound) of oil (1 gallon = 7.2 pounds of jojoba oil). These prices are used to calculate the profit and loss (app. table 13) and cash flow in app. table 14.

5. Yields: Jojoba is a perennial crop. Like many other perennial crops, it does not have any commercial yield for the first few years. It is assumed that commercial yields in jojoba can be harvested in the fourth year (fig. 2). Yields are expected to increase very rapidly until the 10th year. This is due to the natural increase as the plant matures and as a result of technological improvement in growing jojoba, such as new varieties, optimal use of inputs, etc.

A second phase of yield increases is assumed to take place from the 11th year (matured plant) until the maximum expected yield of 2,500 pounds per acre. The increased yield at this phase (4 percent per year) is due to improved technology.

The last phase assumes constant yields at the maximum expected yield until the end of the analysis in the 25th year. The actual harvested yield for jojoba is a function of harvesting efficiency.[4/] It is assumed that harvesting efficiency will be 95 percent although currently the harvesting efficiency is much lower than that. The 95-percent harvesting efficiency is assumed to take place because of increased field yield and development of better harvesting equipment than currently available. Improved harvesting efficiency is also a result of more uniform fields expected from new fields planted with cutting material instead of wild seeds.

The oil yield is a function of both the oil content of the seed and the extraction method. It is assumed that a chemical solvent process will be used to extract the oil. Current chemical solvent process technology will likely be able to extract almost all of the oil available in the seeds. The actual extracted oil can reach 50 percent of the seed weight (fig. 2).

6. Interest Rates: The economic analysis assumes no inflation through the entire period. Therefore, the assumed interest rate (6 percent) is the real interest rate. It is also assumed that the short-term interest rate for working capital loans will be 2 percent above the basic real interest rate indicated above. Thus, the real working capital interest rate is assumed to be 8 percent per year.

7. Length of the Analysis: For simplicity the analysis is carried out over a 25-year period. This is a long enough period to evaluate the crop performance. Although wild jojoba plants are known to survive much longer than 25 years, it is unknown if they can also survive commercially and continue to produce high yields at relative low cost.

4/ Harvesting efficiency represents the ratio of picked or collected yield to the yield available on the plants.

8. Processing and Marketing Costs: Recent estimates by Associated Jojoba Processors, Inc., show that a new solvent extraction plant can extract jojoba oil for as low as $0.15 per pound (3). It is assumed that the total cost of processing, marketing, handling, and storage will be around $0.40 per pound of oil.

Computation Tables and Assumptions

The following pages explain the contents of the 15 tables in the Appendix and some of the specific assumptions used in the analysis. The tables are used for entering data and for computation. Each table contains four parts: row details, units, prices, and table entries.

Appendix Table 1. Investment in an Irrigation System. Currently, various irrigation methods are being used in jojoba. The most common methods are furrow, drip, and overhead linear. The initial investment in furrow irrigation is relatively low; but results in low irrigation efficiency. Overhead linear as well as drip irrigation systems require a relatively large initial investment and have a high irrigation efficiency. The analysis assumes that drip irrigation will be used. The drip irrigation method can cut down on weed control problems, improve cultivation practices, and use less water. An estimated cost of such a system for jojoba was obtained from Netafim Irrigation Inc. (5).

Appendix Table 2. Other Investments. Table 2 shows other investments that might be needed, such as bins for harvesting and tools for maintenance. The analysis does not account for a frost protection system.

Appendix Table 3. Investment in Machines. Table 3 lists the additional number of machines that will be purchased or sold (negative number) at each year and their prices. It is assumed that all the equipment needed for the preplanting operations will be sold at the end of the 3rd year for half of its original purchase price. It is also assumed that the machines will be kept for 10 years and then replaced at the same price.

Appendix Table 4. Summary of Yearly Project Investment. Previously described investments are summarized in this table in addition to a 10-percent unforeseen investment. For calculating profit and loss, it is assumed that the depreciation period for equipment and other investment is 5 years. However, drip irrigation is assumed to depreciate over 9 years since it will be stationary and worn parts will be replaced on a regular basis.

Appendix Table 5. Yearly Capital Recovery of the Project. Based on the assumed length of the depreciation periods, 6 percent real interest rate, and the undepreciated values of the investment, the model calculates capital recovery (interest and depreciation) as equal installment payments using a PMT amortization function available in the LOTUS program.

Appendix Table 6. Machinery Hourly Cost Calculation. The hourly variable costs for machines is based on fuel consumption, fuel prices, machine costs, number of hours used per year, and yearly

repair costs. The total annual repair costs are assumed to be 5 percent of the original purchase price of the equipment.

Appendix Table 7. Variable Costs of Field Operations. Based on the type of equipment used and the performance rate (acres per hour), the program calculates the variable costs (dollars per acre) for each of the field operations specified.

Appendix Table 8. Variable Field Operations of the Entire Project. Part A of the table shows the various field operations and the number of times each operation is needed over the fields. Thus, for example, in the 2nd year, there is a need to row disk 3,000 acres. This means that for the 1,000-acre farm there will be three row disking operations during that year. Part B of the table shows total project field costs for the various field operations based on part A and the per operation cost from table 7.

Appendix Table 9. Labor Requirements and Cost of the Project. Part A lists the various labor requirements for the 1,000-acre farm and wage rates. The wages listed include all monetary benefits and other nonmonetary compensation such as housing, utilities, and provided transportation. Part B lists the annual total labor cost based on the information in part A.

Appendix Table 10. Material Requirement for the Project. The table lists the various materials required and their prices. It is assumed that the planting rate is 900 plants per acre (10 percent male). Replanting will be done at the rate of 10 percent in the second year and 5 percent in the 3rd year. Gypsum is assumed to be used for salinity control in the water at the rate of 0.5 ton per acre-foot of water applied. Liquid nitrogen fertilizer is to be applied via irrigation water.

Appendix Table 11. Material Cost for the Project. Table 11 lists the various costs associated with the previously listed (table 10) materials.

Appendix Table 12. Variable Cost of Water. Part A lists the various assumptions used for calculating the variable costs of water. It is assumed that pumping is done with an electric motor and the price of electricity is $0.05 per kWh. Overall pumping efficiency is the ratio of energy applied to the pump and the actual energy transfer by the pump to lift the water. Irrigation efficiency reflects the quality of the water distributed over the field. It is assumed that the drip irrigation system installed has irrigation efficiency of 95 percent.

Part B lists the actual amount of water needed by the plants as well as the amount of water applied. This amount is equal to crop water needs divided by the irrigation efficiency.

The amount of electricity required for pumping is derived by the following equation:

$$E_r = \frac{Q_w \times 1.024}{P_e} * (P_d + H_r)$$

where:

E_r = total electricity requirement (kWh),

Q_w = quantity of water applied,

1.024 = Amount of electricity required to lift 1 ac-ft of water 1 foot [kWh/(ac-ft*ft)],

P_e = pumping efficiency,

P_d = pumping depth (feet),

H_r = head requirement (feet).

Appendix Table 13. Profit and Loss Analysis of the Project. Part A of the table shows the expected price of oil as outlined in the methodology section. It also shows yield in the field (seeds), harvested yield, and production of oil based on the oil content of the seeds.

Part B shows the income from the sale of oil and the cost of processing and marketing. It is assumed that processing and marketing will be carried out by a cooperative operated by the growers. This means that the cooperative will pass all income from the sale of oil to the growers after deducting its own marketing and processing costs.

Part C summarizes the previously calculated variable costs. It also includes interest on short-term working capital at 8 percent calculated on the basis of 50 percent of the variable costs and the assumed interest rate (see also cash flow analysis).

Part D lists the fixed costs. Insurance is assumed to cost $10 per acre. Taxes include property tax calculated at the rate of 1.5 percent of the value of the undepreciated equipment and the value of the developed land, which is assumed to be worth $2,000 per acre.

Parts E and F show the total annual costs as well as the annual profit and loss. The profit and loss figures include return to the farm-owned resources, such as land, water, etc., and return to management.

Appendix Table 14. Cash Flow Analysis of the Project. This table summarizes the cash flow of the project including income, expenses, and loans. A working capital loan is assumed to be obtained for 50 percent of the total yearly variable costs for each year. However, the working capital loan will be obtained starting in the 4th year when some income becomes available for loan repayment. Repayment of the loan is assumed to be done after 12 months at the interest rate of 8 percent per year (2 percent above the real discount rate).

Part D of the table lists the cumulative cash balance. It also includes the yearly interest charges due to a negative cash balance (credit income from interest when cash balance is positive). Part E is the net present value of the project over 25 years at the project discount rate (6 percent). Part F is the internal rate of return of the project over 25 years.

Appendix Table 15. Annual Per Acre Amortized Present Value. This table expresses the 25 years of jojoba budgets as annual figures. This is done because the economics of jojoba is very dynamic and changing from year to year until the plant reaches maturity. This method can be viewed as an "economic averaging method." It is useful in evaluating the results of perennial crops and other long-term projects. The main difference between statistical mean and economic mean, as used here, is the placing of different weights on different years. The weights used in the economic mean are the discount factors:

$$\frac{1}{(1 + r)^{i}}$$

where: r is the real interest rate and the term i marks the years. For example the weight on the 2nd year with 6 percent real interest rate will be 0.89 whereas the weight on year 25 will be 0.23. (See also equation at the end of app. table 15.)

The actual calculation is done by discounting the yearly figures to obtain the net present value (NPV). NPV is then distributed equally over the years by using the capital recovery factor to amortize the present value over the 25 years of the project.

RESULTS

The LOTUS spreadsheet model produces results on the economic performance of jojoba and facilitates the conduct of array of sensitivity analyses on assumptions and other relationships specified in the analysis. App. tables 13-15 show the results for the base run.

Base Run

The appendix contains the data, assumptions, and results for the base run. Based on current knowledge, the base run case reflects the most likely outcome for well-managed jojoba in the next 10-25 years. However, other outcomes might also be possible under different assumptions. The model is flexible enough to accommodate analyses using other assumptions. The base run model does not reflect current average or typical jojoba farming. This is because existing fields vary greatly; some acres have no chance of ever becoming commercial, while others, with superior plants, stand a much better chance of earning a positive return on the investment.

Under the base run analysis (oil price declines from $30 to $15 a gallon and yield increases from 400 to 2,500 pounds per acre), jojoba is likely to be a profitable venture with an internal rate of return of about 11 percent. However, the payback period, at 13 years, is relatively long (fig. 3). Such a long payback period can present a serious financial problem and a need to rely on outside or other special financing arrangement.

The long payback period will result in a cumulative maximum negative cash balance of about $3.8 million for the 1,000-acre jojoba plantation.

The average break-even yield, including nonbearing years at the assumed prices, is 817 pounds per acre. This means that, on average, the yield should exceed 817 pounds per acre to cover all expenses including the initial investment. The actual average harvested yield is expected to be 1,360 pounds per acre.

The average break-even price is $10.28 per gallon of jojoba oil. It is calculated under the assumption that yields will be at their average level as stated above. The actual average price for the base run analysis is $18 per gallon.

Sensitivity Analysis

The economic analysis of jojoba as mentioned earlier requires many assumptions. The two most critical assumptions are those regarding yields and jojoba oil prices. Since one cannot be completely sure about these assumptions, a series of sensitivity analyses is presented. The sensitivity analysis, summarized in table 1, is multidimensional involving changes in oil prices and jojoba yields. The analysis sets three levels for both oil prices and yields, that is, 30-percent decrease from the base run, base run, and 30-percent increase from the base run. For each combination, five results are presented: net present value (NPV), internal rate of return (IRR), break-even yield, break-even price, and payback period. Each of the above terms is explained as follows:

- Net present value (NPV) is the discounted present value of the net cash flow for the 25 years of the project.

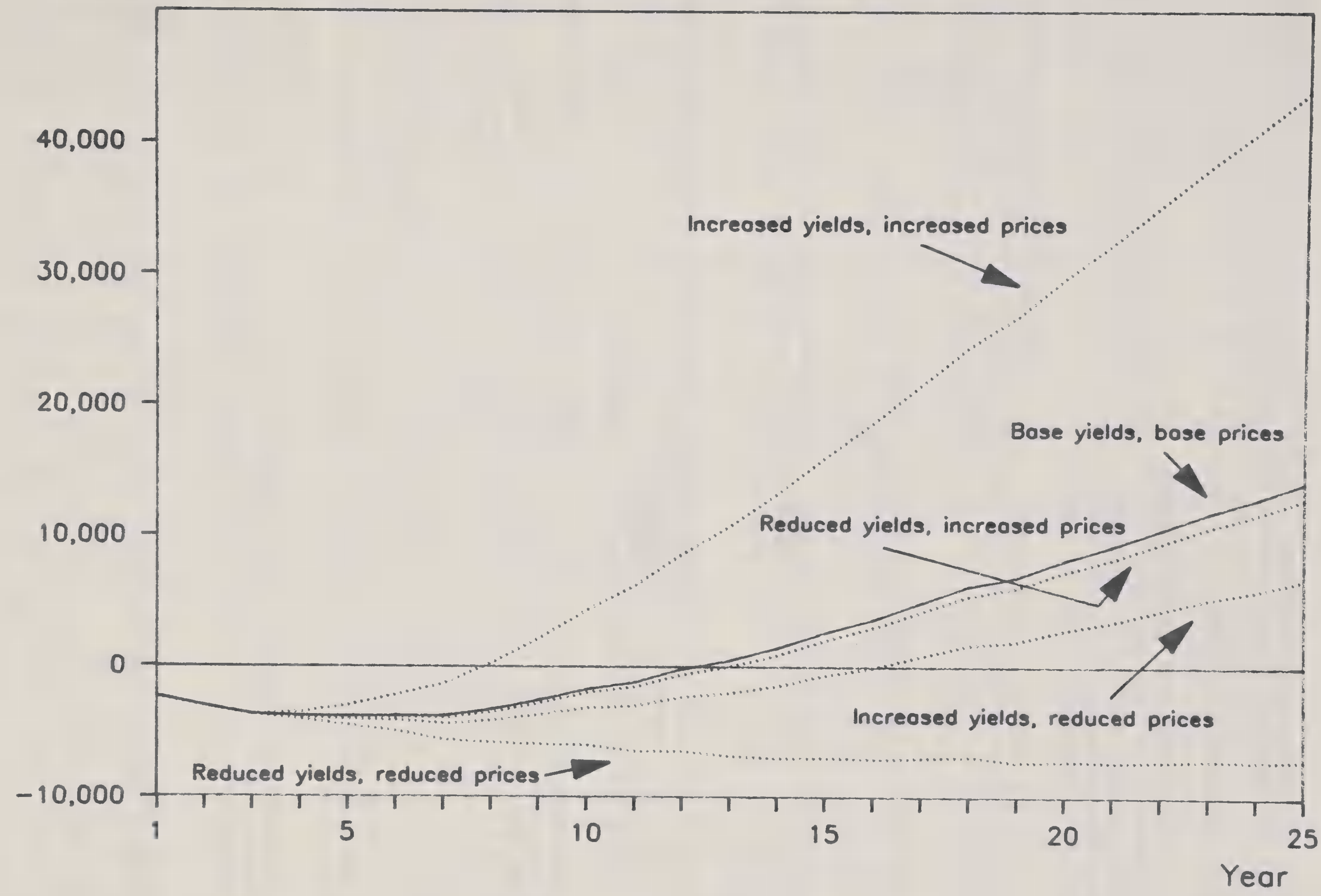
- Internal rate of return (IRR) is the calculated discount rate which equates the net present value to zero.

- Break-even yield is the minimum annual (including nonyielding years) average yield required to cover the entire investment and the annual costs of the project.

- Break-even price is the minimum annual (including nonyielding years) average oil price required to cover the entire investment and the annual costs of the project.

- Payback period is the minimum number of operating years required to cover the initial investment and the annual costs incurred until that time.

Figure 3. Cumulative cash balances under different alternatives



Reduced Prices and Reduced Yields. This is the worst-case situation, where prices and yields are assumed to be 30 percent lower than in the base run. The summary of results (table 1) clearly shows that, under such a situation, jojoba might not be economical.

Reduced Prices and Base Yields. This alternative assumes prices to decrease from $21 per gallon to $10.50 per gallon over the first 10 years of the project. However, it assumes that yields can reach their base level. The economic outcome is negative and the payback period is greater than 25 years.

Reduced Prices and Increased Yields. This alternative assumes yields to reach a maximum of 3,250 pounds per acre while prices are 30 percent below the base level. Under such a situation, jojoba is marginally profitable but the payback period is very long (17 years).

Base Prices and Reduced Yields. A maximum yield of 1,750 pounds per acre will make jojoba unprofitable if prices remain at their base level (table 1).

Base Prices and Base Yields. This alternative is the base run. Jojoba production is economical with an internal rate of return (IRR) around 11 percent. The payback period is still long, around 13 years.

Base Prices and Increased Yields. Increased yields above the base prices will make jojoba quite profitable with IRR of about 17 percent and a payback period of 10 years. The payback period includes the first 3 years where there is no income.

Increased Prices and Reduced Yields. The effect of 30-percent higher prices and lower yields by 30 percent tend to cancel each other such that the overall impact is very similar to that of the base run. It should be emphasized that the economic outcome of the opposite situation, prices reduced 30 percent and yields increased by 30 percent, is inferior to the base run. Thus, while higher prices can compensate for lower yields, lower prices cannot be compensated with higher yields at the same proportion. This situation occurs because increased yields also mean increased processing and marketing costs. Thus, the net per acre income is lower than with the opposite situation.

Increased Prices and Base Yields. Under such a situation, jojoba production is quite profitable. IRR is around 18 percent and the payback period is down to 10 years, including the non-bearing years. The net present value of the project is around $8,700 per acre.

Increased Prices and Increased Yields. This is the most optimistic outcome where both prices and yields are expected to be 30 percent above the base run. Under such a situation, jojoba production is very profitable with a net present value (NPV) around $14,700 per acre. The internal rate of return (IRR) is 23.7 percent and the payback period is 8 years. It should be emphasized, of course, that this outcome is not likely to take place since higher yields tend to increase supply, which is likely to force market prices down.

Table 1--Sensitivity analysis results for jojoba

Price changes	Unit	Yield changes: Reduced 30 percent	Yield changes: Base	Yield changes: Increased 30 percent
Reduced prices (-30%):				
Net present value (NPV)	Dollars/acre	-5,196	-2,477	242
Internal rate of return (IRR)	Percent	-21.73	-0.15	6.48
Break-even yield	Pounds/acre	1,151.50	1,166.93	1,182.35
Break-even price	Dollars/gallon	14.49	10.28	8.01
Payback period	Years	NA	NA	17
Base prices:				
Net present value (NPV)	Dollars/acre	-1,287	3,108	7,502
Internal rate of return (IRR)	Percent	3.19	11.21	16.73
Break-even yield	Pounds/acre	806.05	816.85	827.65
Break-even price	Dollars/gallon	14.49	10.28	8.01
Payback period	Years	20	13	10
Increased prices (+30%):				
Net present value (NPV)	Dollars/acre	2,623	8,693	14,763
Internal rate of return (IRR)	Percent	10.47	17.97	23.65
Break-even yield	Pounds/acre	620.04	628.34	636.65
Break-even price	Dollars/gallon	14.49	10.28	8.01
Payback period	Years	13	10	8

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5. Netafim Irrigation, Inc. Estimated Costs of Drip Irrigation in Jojoba. Phoenix, AZ. April 1986.

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11. Wright, G. N., J. G. Taylor, and K. E. Foster. Alternatives to Desertification in Arid Lands Agriculture: The Economic Feasibility of New, Arid-Adapted Crops. Office of Arid Land Studies, University of Arizona, Tucson. Aug. 1985.

Appendix: Jojoba Budget

First 9 years of jojoba base budget for 1,000 acres: Central Arizona and Southern California

	Assumptions	Value
1.	Expected initial price of jojoba oil	30.00 dollars per gallon
2.	Expected minimum price of jojoba oil	15.00 dollars per gallon
3.	Exponent of price reduction equation	.30
4.	Real interest rate	6.00 percent
5.	Length of the analysis	25 Years
6.	Expected initial yield at the 4th year	400 pounds per acre
7.	Expected full-grown yield at the 10th year	2,000 pounds per acre
8.	Expected rate of yield increase after the 10th year	4.00 percent per year
9.	Maximum expected yield	2,500 pounds per acre
10.	Oil content of seeds (actual extracted oil)	50 percent
11.	Processing and marketing cost	.40 dollars per pound
12.	Proportion of yield harvested	95.00 percent

Appendix table 1--Investment in drip irrigation system for jojoba[1/]

Item	Unit	Dollars per Unit	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
			Units per acre								
Driplines, accessories, and installation	Acre	345.00	1.00	0	0	0	0	0	1.00	0	0
Pumps, valves, filter-station, and installation	Acre	155.00	1.00	0	0	0	0	0	0	0	0
P.V.C. pipes, fittings, and installation	Acre	122.00	1.00	0	0	0	0	0	0	0	0
Replacement parts	Acre	622.00	0	.05	.05	.05	.05	.05	.05	.05	.05
Total	1,000 dollars		622.00	31.10	31.10	31.10	31.10	31.10	376.10	31.10	31.10

1/ Based on estimates made by Netafim Irrigation, Inc.

Appendix table 2--Other investments

Item	Unit	Dollars per Unit	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
			Units per acre								
Miscellaneous tools	Dollars		10,000	0	0	0	0	5,000	0	0	0
Bins for harvesting	Numbers	70	40	0	0	0	0	40	0	0	0
Fuel tanks	Numbers	1,000	2	0	0	0	0	0	0	0	0
Total	1,000 dollars		14.80	0	0	0	0	7.80	0	0	0

Appendix table 3--Investments in machines

Machines: Name	Code	Dollars per unit	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
			Units per 1,000 acres								
Land planer	1	7,770	1	0	-1 2/	0	0	0	0	0	0
Disk (13 feet)	2	12,450	1	0	-1	0	0	0	0	0	0
Lister (5 bottom)	3	5,000	1	0	-1	0	0	0	0	0	0
Transplanter	4	2,450	1	0	-1	0	0	0	0	0	0
Tractors 60 horsepower	5	21,000	1	0	0	0	0	0	0	0	0
Tractors 70 horsepower	6	25,500	2	0	0	0	0	0	0	0	0
Tractors 125 horsepower	7	47,500	2	0	0	0	0	0	0	0	0
Row cultivators	8	4,100	2	0	0	0	0	0	0	0	0
Disks (6 feet)	9	3,500	2	0	0	0	0	0	0	0	0
Row bucker	10	1,500	1	0	0	0	0	0	0	0	0
Sprayers	11	3,600	2	0	0	0	0	0	0	0	0
Hedger/pruner	12	2,000	0	0	1	0	0	0	0	0	0
Jojoba harvester (60 horsepower)	13	44,000	0	0	0	4	0	2	0	0	0
Trailers	14	3,000	1	0	0	0	0	0	0	0	0
Service wagons	15	1,500	1	0	0	0	0	0	0	0	0
Pickups	16	11,000	2	0	0	0	2	0	0	0	0
All terrain cycle (ATC)	17	1,500	1	0	0	0	0	1	0	0	0
			1,000 dollars								
Total investment			246.57	0	-11.84	176.00	22.00	89.50	0	0	0

2/ Negative numbers indicate selling of equipment at 50 percent of the original price.

Appendix table 4--Summary of yearly project investments

Investment	Depreciation period	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
	Years	1,000 dollars								
Irrigation system	9	622.00	31.10	31.10	31.10	31.10	31.10	376.10	31.10	31.10
Other investments	5	14.80	0	0	0	0	7.80	0	0	0
Farm machines	5	246.57	0	-11.84	176.00	22.00	89.50	0	0	0
Unforeseen investments (10 percent)	5	88.34	3.11	1.93	20.71	5.31	12.84	37.61	3.11	3.11
Total		971.71	34.21	21.19	227.81	58.41	141.24	413.71	34.21	34.21

Appendix table 5--Yearly capital recovery of the project

Investment	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
	1,000 dollars								
Irrigation system	91.45	96.02	100.59	105.17	109.74	22.86	73.58	73.58	73.58
Other investments	3.51	3.51	3.51	3.51	3.51	1.85	1.85	1.85	1.85
Farm machines	58.53	58.53	55.73	97.51	102.73	65.44	65.44	68.25	26.47
Unforeseen investments	20.97	21.71	22.17	27.08	28.34	10.42	18.61	18.89	14.71
Total	174.47	179.78	182.00	233.27	244.32	100.58	159.49	162.58	116.62

Appendix table 6--Machinery hourly cost calculation

Machines: Name	Code	Fuel use[1]	Fuel and lubrication	Working time	Parts and repair[2]	Variable costs	Time required, 1st year
		Gallons/hour	Dollars per hour	Hours per year	Dollars per hour	Dollars per year	Hours
Land planer	1			250	1.55	1.55	250
Disk (13 feet)	2			1,000	.62	.62	1,000
Lister (5 bottom)	3			250	1.00	1.00	250
Transplanter	4			1,000	.12	.12	2,000
Tractors 60 horsepower	5	2.9	3.81	800	1.31	5.12	3,400
Tractors 70 horsepower	6	3.4	4.44	800	1.59	6.04	2,050
Tractors 125 horsepower	7	6.0	7.93	800	2.97	10.90	1,500
Row cultivators	8			750	.27	.27	750
Disks (6 feet)	9			750	.23	.23	750
Row bucker	10			50	1.50	1.50	50
Sprayers	11			800	.23	.23	1,600
Hedger/pruner	12			1,000	.10	.10	0
Jojoba harvester 60 horsepower	13	2.9	3.81	500	4.40	8.21	0
Trailers	14			300	.50	.50	300
Service wagons	15			500	.15	.15	
Pickups (cost per mile)	16					.16	
All terrain cycle (ATC) (cost per mile)	17					.02	

1/ Price of diesel fuel at $1.15 per gallon.

2/ Repair costs at 5 percent of investment.

Appendix table 7--Variable costs of field operations

Field operation	Power unit code	Machine unit code	Cost per hour	Performance rate	Total cost
			Dollars	Acres/hour	Dollars/acre
Land planing	7	1	12.46	4.0	3.11
Custom deep ripping					50.00
Rented tractor			12.00		
Disking	7	2	11.53	2.0	5.76
Furrowing	7	3	11.90	4.0	2.98
Preplant herbicide application	7	11	11.13	8.0	1.39
Transplanting	6	4	6.16	.5	12.32
Row disking, 1st year	5	9	5.35	4.0	1.34
Row disking, 2nd year	5	9	5.35	4.0	1.34
Row disking, 3rd year	5	9	5.35	4.0	1.34
Row cultivating, 1st year	5	8	5.39	4.0	1.35
Row cultivating, 2nd year	5	8	5.39	4.0	1.35
Row cultivating, 3rd year	5	8	5.39	4.0	1.35
Row herbicides spraying	5	11	5.35	2.5	2.14
Mechanical hedging	6	12	6.14	.5	12.27
Row bucking	6	10	7.54	20.0	0.38
Jojoba harvesting	13		8.21	1.0	8.21
Hauling and miscellaneous	5	14	5.62	10.0	0.56
Crop hauling and drying (ton)					50.00

Appendix table 8--Variable field operation costs of the entire project

Item	Unit	Price	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
		Dollars/unit	Acres treated								
Part A--Field operations:											
Land planing	Acre	3.11	1,000	0	0	0	0	0	0	0	0
Custom deep ripping	Acre	50.00	1,000	0	0	0	0	0	0	0	0
Rented tractors	Hour	12.00	2,950	0	0	0	0	0	0	0	0
Disking	Acre	5.76	2,000	0	0	0	0	0	0	0	0
Furrowing	Acre	2.98	1,000	0	0	0	0	0	0	0	0
Preplant herbicide application	Acre	1.39	2,000	0	0	0	0	0	0	0	0
Transplanting	Acre	12.32	1,000	0	0	0	0	0	0	0	0
Row disking	Acre	1.34	3,000	3,000	3,000	2,500	2,000	1,500	1,500	1,500	1,500
Row cultivating	Acre	1.35	3,000	3,000	3,000	2,500	2,000	1,500	1,500	1,500	1,500
Row herbicides spraying	Acre	2.14	4,000	4,000	4,000	3,000	3,000	3,000	2,000	2,000	2,000
Mechanical hedging	Acre	12.27	0	0	1,000	0	1,000	0	1,000	0	1,000
Row bucking	Acre	.38	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Jojoba harvesting	Acre	8.21	0	0	0	2,000	2,000	3,000	3,000	3,000	3,000
Hauling and miscellaneous	Acre	.56	3,000	1,000	1,000	2,000	2,000	2,000	2,000	2,000	2,000
Miscellaneous pickup driving	1,000 miles	50.00	100	100	100	100	100	100	100	100	100
Miscellaneous ATC driving	1,000 miles		20	20	20	20	20	20	20	20	20
Crop hauling and drying	Ton		0	0	0	190	317	443	570	697	823

Continued--

Appendix table 8--Variable field operation costs of the entire project (continued)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
					Dollars				
Part B--Costs of field operations:									
Land planing	3,114	0	0	0	0	0	0	0	0
Custom deep ripping	50,000	0	0	0	0	0	0	0	0
Rented tractors	35,400	0	0	0	0	0	0	0	0
Disking	11,526	0	0	0	0	0	0	0	0
Furrowing	2,976	0	0	0	0	0	0	0	0
Pre plant herbicide application	2,782	0	0	0	0	0	0	0	0
Transplanting	12,320	0	0	0	0	0	0	0	0
Row disking	4,016	4,016	4,016	3,347	2,677	2,008	2,008	2,008	2,008
Row cultivating	4,046	4,046	4,046	3,372	2,697	2,023	2,023	2,023	2,023
Row herbicide spraying	8,554	8,554	8,554	6,416	6,416	6,416	4,277	4,277	4,277
Mechanical hedging	0	0	12,275	0	12,275	0	12,275	0	12,275
Row bucking	377	377	377	377	377	377	377	377	377
Jojoba harvesting	0	0	0	16,418	16,418	24,626	24,626	24,626	24,626
Hauling and miscellaneous	1,686	562	562	1,124	1,124	1,124	1,124	1,124	1,124
Miscellaneous pickup driving	16,000	6,000	16,000	16,000	16,000	16,000	16,000	16,000	16,000
Miscellaneous ATC driving	400	400	400	400	400	400	400	400	400
Crop hauling and drying	0	0	0	9,500	15,833	22,167	28,500	34,833	41,167
Total cost of field operations	153,198	33,955	46,230	56,953	74,217	75,141	91,610	85,669	104,277

Appendix table 9--Labor requirement and cost

Item	Unit	Price	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
		Dollars/unit	Units								
Part A--Labor requirements:											
Farm manager	Man-year	35,000	1	1	1	1	1	1	1	1	1
Tractor operators	Man-year	19,500	2	2	2	2	2	2	2	2	2
Supervisory field labor	Man-year	22,000	1	1	1	1	1	1	1	1	1
Mechanics and maintenance	Man-year	22,000	1	1	1	1	1	1	1	1	1
Irrigating	Man-month	1,200	8	8	8	8	8	8	8	8	8
Weeding	Man-day	45	800	800	800	800	800	700	700	600	500
Harvesting	Man-month	950	0	0	0	20	20	20	20	20	20
Temporary tractor drivers	Man-month	1,200	16	16	16	16	16	16	16	16	16
Transplanting	Man-day	45	500	50	25	0	0	0	0	0	0
			Dollars								
Part B--Labor costs:											
Farm manager			35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000
Tractor operators			39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000
Supervisory field labor			22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000
Mechanics and maintenance			22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000
Irrigating			9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600
Weeding			36,000	36,000	36,000	36,000	36,000	31,500	31,500	27,000	22,500
Harvesting			0	0	0	19,000	19,000	19,000	19,000	19,000	19,000
Temporary tractor drivers			19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200
Transplanting			22,500	2,250	1,125	0	0	0	0	0	0
Total			205,300	185,050	183,930	201,800	201,800	197,300	197,300	192,800	188,300

Appendix table 10--Material requirements of the project

Item	Unit	Price per unit	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
		Dollars	Units								
Fertilizers and plants:											
Female plants	1,000	500	810.0	81.0	40.5	0	0	0	0	0	0
Male plants	1,000	500	90.0	9.0	4.5	0	0	0	0	0	0
Liquid nitrogen (N)	1,000 pounds	300	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Herbicides:1/											
Treflan	1,000 pounds	8,750	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Goal	1,000 pounds	16,000	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Roundup	1,000 gallons	85,000	.1	.1	.1	.1	.1	0	0	0	0
Other materials:											
Gypsum ($CaSO_4$)	Ton	300	1,315.8	1,052.6	1,052.6	1,052.6	1,315.8	1,315.8	1,578.9	1,578.9	1,578.9

1/ Currently, not all the herbicides listed above are registered for use in jojoba production.

Appendix table 11-- Material requirements of the project

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
	1,000 dollars								
Fertilizers and plants:									
Female plants	405.00	40.50	20.25	0	0	0	0	0	0
Male plants	45.00	4.50	2.25	0	0	0	0	0	0
Liquid nitrogen (N)	0	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Herbicides:									
Treflan	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50
Goal	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00
Roundup	8.50	8.50	8.50	8.50	8.50	0	0	0	0
Other materials:									
Gypsum ($CaSO_4$)	39.47	31.58	31.58	31.58	39.47	39.47	47.37	47.37	47.37
Total material cost	547.47	164.58	142.08	119.58	127.47	118.97	126.87	126.87	126.87

Appendix table 12--Variable cost of water

Item	Unit	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Annual crop water needs	Acre-inch	30.0	24.0	24.0	24.0	30.0	30.0	36.0	36.0	36.0
Annual irrigation water needs	Acre-Inch	31.6	25.3	25.3	25.3	31.6	31.6	37.9	37.9	37.9
Total water requirement	Acre-foot	2,632	2,105	2,105	2,105	2,632	2,632	3,158	3,158	3,158
Electricity for water pumping	1,000 kWh	2,450	1,960	1,960	1,960	2,450	2,450	2,940	2,940	2,940
Electricity cost 1/	$ 1,000	22.49	97.99	97.99	97.99	122.49	122.49	146.99	146.99	146.99
Other variable costs 2/	$ 1,000	18.37	14.70	14.70	14.70	18.37	18.37	22.05	22.05	22.05
Total 3/	$ 1,000	140.86	112.69	112.69	112.69	140.86	140.86	169.03	169.03	169.03

1/ Price of electricity $0.05 per kWh.

2/ Assumes 25 percent of other variable costs.

3/ Average variable cost of water--$53.53 per acre-foot.

Based on the following assumptions:

1. Pumping depth--400 feet,
2. Head requirement--100 feet,
3. Overall pumping efficiency--55 percent,
4. Irrigation efficiency--95 percent,
5. Power unit--electric motor,
6. Energy required to lift 1 acre-foot of water 1 foot--1.024 kWh,
7. Irrigation method--drip irrigation.

Appendix table 13--Profit and loss analysis

Item	Unit	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
		Units								
Part A--Output:										
Oil prices	Dollars/gallon	30.00	24.37	21.58	19.79	18.51	17.53	16.73	16.08	15.52
Field yield (seeds)	Pounds/acre	0	0	0	400	667	933	1,200	1,467	1,733
Harvested yield (seeds)	Pounds/acre	0	0	0	380	633	887	1,140	1,393	1,647
Total production (seeds)	Tons	0	0	0	190	317	443	570	697	823
Total production (oil)	1,000 pounds	0	0	0	190	317	443	570	697	823
Part B--Income:										
Oil sale	1,000 dollars	0	0	0	522.31	814.14	1,079.13	1,324.75	1,555.56	1,774.56
Less processing and marketing	1,000 dollars	0	0	0	76.00	126.67	177.33	228.00	278.67	329.33
Total income	1,000 dollars	0	0.	0	446.31	687.48	901.80	1,096.75	1,276.89	1,445.23
Part C--Variable costs:										
Field operations	1,000 dollars	153.20	33.96	46.23	56.95	74.22	75.14	91.61	85.67	104.28
Labor	1,000 dollars	205.30	185.05	183.93	201.80	201.80	197.30	197.30	192.80	188.30
Materials	1,000 dollars	547.47	164.58	142.08	119.58	127.47	118.97	126.87	126.87	126.87
Water	1,000 dollars	140.86	112.69	112.69	112.69	140.86	140.86	169.03	169.03	169.03
Interest on working capital 1/	1,000 dollars	41.87	19.85	19.40	19.64	21.77	21.29	23.39	22.97	23.54
Overhead and unforeseen 2/	1,000 dollars	108.87	51.61	50.43	51.07	56.61	55.36	60.82	59.73	61.20
Total variable costs	1,000 dollars	1,197.58	567.74	554.75	561.73	622.74	608.92	669.03	657.08	673.22

See notes at end of table.

Continued--

Appendix table 13--Profit and loss analysis (continued)

Item	Unit	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year [illegible]	Year 9
		Units								
Part D--Fixed costs:										
Interest and depreciation	1,000 dollars	174.47	179.78	182.00	233.27	244.32	100.58	159.49	162.58	116.62
Insurance3/	1,000 dollars	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Taxes4/	1,000 dollars	41.96	39.78	37.36	37.28	34.49	35.10	38.92	36.99	35.75
Overhead5/	1,000 dollars	119.76	56.77	55.48	56.17	62.27	60.89	66.90	65.71	67.32
Total fixed costs	1,000 dollars	346.18	286.33	284.84	336.72	351.09	206.57	275.31	275.28	229.70
Part E--Total project costs:	1,000 dollars	1,543.76	854.06	839.59	898.45	973.83	815.49	944.33	932.36	902.92
Part F--Profit:	1,000 dollars	-1,543.76	-854.06	-839.59	-452.14	-286.35	86.30	152.42	344.54	542.32

1/ Calculated at 8 percent real interest rate.
2/ Calculated at 10 percent of variable costs.
3/ Calculated at $10 per acre.
4/ Calculated at 1.5 percent of capital assets.
5/ Calculated at 10 percent of variable costs.

Appendix table 14--Cash flow nalysis of the project

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
	1,000 dollars								
Part A--Inflow:									
Revenue from oil sales	0	0	0	446	687	902	1,097	1,277	1,445
Long-term loans	0	0	0	0	0	0	0	0	0
Working capital loans	0	0	0	281	311	304	335	329	337
Total inflow	0	0	0	727	999	1,206	1,431	1,605	1,782
Part B--Outflow:									
Total variable costs	1,198	568	555	562	623	609	669	657	673
Total project investments	972	34	21	228	58	141	414	34	34
Insurance	10	10	10	10	10	10	10	10	10
Taxes	42	40	37	37	34	35	39	37	36
Long-term loan payments 1/	0	0	0	0	0	0	0	0	0
Working capital loan payments 1/	0	0	0	0	303	336	329	361	355
Total outflow	2,221	652	623	837	1,029	1,132	1,460	1,100	1,108
Part C--Net cash balance	-2,221	-652	-623	-110	-30	75	-29	506	674
Part D--Cumulative cash balance 2/	-2,355	-3,045	-3,706	-3,822	-3,854	-3,775	-3,806	-3,270	-2,555

Part E--Net present value--3,108,000 dollars 3/

Part F--Internal rate of return--11.21 percent

1/ Including principal and interest payments.
2/ Including interest.
3/ Calculated at 6 percent real interest for 25 years.

Appendix table 15--Annual average per acre results for jojoba

Item	Unit	Amortized present value 1/	proportion of gross income	Proportion of total costs
		Units	Percent	Percent
Output:				
Harvested seed yield	Pounds/acre	1,359.04		
Harvested oil yield	Pounds/acre	679.52		
Oil price	Dollars/gallon	18.00		
Income:				
Gross income	Dollars	1,456.31	100.00	
Less processing and marketing costs	Dollars	271.81	18.66	
Total income	Dollars	1,184.50	81.34	
Variable costs:				
Field operations	Dollars	95.23	6.54	9.82
Labor	Dollars	189.75	13.03	19.56
Materials	Dollars	160.68	11.03	16.56
Water	Dollars	152.64	10.48	15.73
Interest on working capital	Dollars	23.93	1.64	2.47
Overhead and unforeseen	Dollars	62.22	4.27	6.41
Total variable costs	Dollars	684.45	47.00	70.56

See notes at end of table.

Continued--

Appendix table 15--Annual average per acre results for jojoba (continued)

Item	Unit	Amortized present value 1/	proportion of gross income	Proportion of total costs
		Units	Percent	Percent
Fixed costs:				
Interest and depreciation	Dollars	168.66	11.58	17.39
Insurance	Dollars	10.00	0.69	1.03
Taxes	Dollars	38.51	2.64	3.97
Overhead	Dollars	68.45	4.70	7.06
Total fixed costs	Dollars	285.62	19.61	29.44
Total per acre costs:	Dollars	970.07	66.61	100.00
Profit	Dollars	214.43	14.72	
Break-even seed yield	Pounds/acre	816.85		
Break-even oil prices	Dollars/gallon	10.28		

1/ The equation used in the computation is:

$$M = \left[\sum_{i=1}^{25} \left[\frac{X_i}{(1 + r)^i} \right] \right] * \left[\frac{r(1 + r)^i}{(1 + r)^i - 1} \right]$$

Where: M is the economic weighted mean of the time series,
X_i is the yearly figure (i=1.... 25),
i is the year (i=1.... 25),
r is the real interest rate.

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